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Airborne Platforms for Emergency Communications and Reconnaissance in Domestic Disaster Response

BY

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Disclaimer

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Abstract

Since the 19th century, aircraft have played a significant role in military operations worldwide. From the use of observation balloons in the American Civil War, to the introduction of jet-powered aircraft in World War II, to the advent of remotely piloted aircraft (RPA) like the Reaper and Global Hawk, the role of aircraft has been ever expanding as technology advances in our nation's Air Force. One of the initial roles of military of aircraft was to provide intelligence, surveillance and reconnaissance (ISR) to battlefield commanders. That role continues today in a variety of situations. One of those situations is disaster response in the continental United States. US Air Force aircraft and sensor technology can provide detailed imagery and video of affected areas to assist with relief efforts. These aircraft can also be used to assist in another critical area of disaster response: communications restoral. Multi-role aircraft, manned, unmanned, and remotely piloted can be used to provide this ISR capability and provide communications service to an area affected by a disaster. Responding to a US Northern Command requirement, this research paper will explore which types of airborne platforms, to include airships, tethered aerostats, traditional heavier than air remotely piloted platforms, and others, can provide emergency communications and wide area surveillance both prior to a disaster situation, and during the US Government's response operations. The US Government response to Hurricane Katrina will be used as a case study to determine exactly what communications and ISR capabilities will be required to support disaster response operations. Lessons learned from Hurricane Katrina will also be explored.

Hurricane Katrina: A Case Study

Hurricane Katrina was the largest natural disaster that the United States had ever faced, causing an estimated $200 billion in damages.[1] There has been much analysis of the US Government's response to the disaster. This section will explore what happened to communications in and around New Orleans during the storm, lessons learned that could be applied to future disaster scenarios, and some military communications and ISR capabilities that can support pre and post-disaster operations.

Prior to Hurricane Katrina, the city of New Orleans had a population of 485,000 people[2] and a robust economy, primarily focused in the areas of tourism, port operations, and educational services.[3] Telecommunications are foundational in our nation's economy, so the loss of these services can have a dramatic impact on a region that loses communications due to a natural disaster or other event. One consideration often not discussed by the military is restoral of civil communications (both government and commercial) after a disaster. There are many technologies that can be considered, and one of the potential solutions is the use of airborne platforms to temporarily restore this critical infrastructure. Those technologies will be explored later in this paper.

One of the keys to successful disaster response happens far in advance of the event. The first hours and days after a disaster are critical. This key is the deliberate planning of the response to a disaster. The governmental organizations in charge must quickly gain situational awareness and begin rescue and response operations. One of the critical considerations must be communications planning, not only for military and other federal responders, but also for the state and local communities. In the event that communications such as cellular telephones and land mobile radios are disabled, first responders will be isolated. This was experienced during

the September 11 attack in New York City. In the chaos of the first hours following the attack, first responders immediately rushed to the World Trade Center to begin rescuing survivors. Unfortunately, their radio networks were not operating properly, leaving some isolated. After the South Tower collapsed, an evacuation of firefighters in the North Tower was ordered, but it is unclear if all of the firefighters received the message. In a 2005 New York Times article, it was stated, "Some firefighters described receiving a radio message to evacuate; others used strong language to characterize the communications gear as useless."[4]

Figure 1: Delacroix, LA Telephone Switching Facility destroyed by Hurricane Katrina[5]

Similar failures of first responders' communications were seen during the aftermath of Hurricane Katrina. In a news conference on August 29, 2005, only hours into the rescue effort, New Orleans Police Superintendant Eddie Compass explained that his police officers were working with no communications; a problem he said was akin to running out of ammunition.[6] In addition to the communications problems faced by first responders, a US government agency noted, "Dozens of 911 call centers were out of service…Most landlines were down and 70 percent of cell towers in New Orleans had failed."[7] Across the entire Gulf Coast region, an estimated 750,000 landline customers and millions of cell phone customers were without service

due to damage from the storm.[8] This effectively eliminated the ability for people to call for help, and many 911 call centers were down, anyway. Further complicating response efforts, state and local governments were not able to communicate adequately with federal government agencies. With the amount of satellite communications technology available, it is hard to believe that a local government agency can be completely cut off in the event of a disaster. Testifying before Congress after the disaster, New Orleans Mayor Ray Nagin stated that he had, “a huge box of satellite telephones that did not work.”[9] During the Katrina disaster, federal government officials from the National Communications System, the lead for national communications issues, found that there were no problems with satellite phone communications during the time after Katrina. The inability for state and local officials to use satellite phones was due to a multitude of issues: lack of training, expired service contracts that were not renewed, and attempting to use the phones indoors, among other issues.[10] The physical effects of Hurricane Katrina (flooding, power outages, and damaged communications towers) had a catastrophic impact on communications in the region, but as these examples showed, there were also planning and training issues that exacerbated an already bad situation.

Figure 2: US Army Satellite Terminal at Louis Armstrong Int'l Airport supporting Katrina relief operations[11]

Lessons Learned

Out of the chaos and confusion of Hurricane Katrina, there are some lessons to be learned on how to better prepare for the communications service degradations that will occur during a disaster scenario and improve situational awareness.

The first lesson is that the communications planning for disaster scenarios needs to be improved. Closer coordination between federal government agencies (DoD, DHS), state government and local government must happen now, in order to be prepared for future disasters. Often, when the military is called in to support a disaster relief operation, the focus of communications planning is support of the military forces involved. Under the leadership of US Northern Command, coordinating with other federal, state, and local governments, military communications planning must evolve to include restoral and support of critical civil communications services, such as first responders' radio networks, cellular telephones, telecommunications supporting financial systems, and service to government command centers. Some of this military support to civil communications was demonstrated during Katrina relief

operations. On September 10, 2005, the US Army deployed a satellite communications terminal to Louis Armstrong New Orleans International airport to establish communications links to restore service between cell towers and the public switch telephone network.[12] They initially planned to extend Non-Secure Internet Protocol Routed Network (NIPRNET) and Defense Switched Network (DSN) services to civilian organizations that needed communications. This is the standard military way of providing tactical communications. That plan did not work. Chief Warrant Officer Joseph Kosbar, one of the Army's communications personnel on the ground, said, "We could not legally shoot back into military facilities to provide services to first responders."[13] Although this attempt to use military equipment and personnel to provide services to civilians fell short, the intent here was going in the right direction. Instead of discovering at the last minute that a legal issue prevents civilian agencies from using military communications, that plan should be worked out far in advance, published, and then exercised periodically along with our civilian counterparts. A Government Accountability Office report on Hurricane Katrina filed in May 2006 stated, "…DOD's emergency response plan, Functional Plan 2501, addressed internal military communications requirements, but it did not address the communication requirements of communities affected by a catastrophic natural disaster. It also did not address coordination with civilian responders."[14] Using organic National Guard communications equipment and personnel may be an ideal solution for this capability. The capacity to use military satellite communications terminals to provide service through a civilian provider exists, and this arrangement could be used during a disaster scenario, if some of the legal hurdles are insurmountable. Another capability that should be explored is the establishment of a civil tactical communications capability at the state level. These units could provide an emergency communications capability similar to what the military has. There are many technical solutions

that can be applied to this lesson learned from Hurricane Katrina, but the initial planning for military-civil cooperation for emergency communications must begin, be ingrained in our operations, and exercised routinely.

The next lesson learned is that airborne, persistent ISR aircraft can provide situational awareness and positively affect rescue and recovery operations. With the degraded communications after Katrina, obtaining surveillance of the affected area was a key to coordinating effective rescue efforts. In early 2005, the Department of Homeland Security (DHS) issued the National Response Plan (NRP), which has since been replaced with the National Response Framework. The NRP's purpose was to, "enable all response partners to prepare for and provide a unified national response to disasters and emergencies."[15] The NRP specified that local and state officials are responsible for damage assessments during a disaster, but it also noted that state and local officials could be overwhelmed in a catastrophe. Despite that being a likely scenario, the NRP did not specify the proactive means necessary for the federal government to gain situational awareness when state and local officials are overwhelmed.[16] DoD's pre-disaster planning did not call for the use of the military ISR assets to meet the NRP's requirement for a proactive response to catastrophic incidents.[17] Military ISR assets were eventually called upon to assist in damage assessment. U-2 reconnaissance aircraft from Beale AFB, California, were tasked to fly missions over the Gulf Coast area, providing imagery of the damage to local civilian government agencies. They were able to bring the U-2's impressive imagery intelligence capabilities to bear, photographing over 130,000 square miles, providing high-quality imagery with the necessary detail for close analysis.[18] The key point here is that military aircraft, designed for combat operations, can use their capabilities to assist in domestic disasters. The planning and integration of these assets into overall disaster plans must be

undertaken. As a part of pre-disaster planning, it must be decided which assets will potentially be needed, and those requirements must be communicated to DoD through USNORTHCOM. Aerial and satellite imagery of potential disaster areas should be maintained and updated, so there are before and after images to compare to assist in determining the extent of damage in a specific area. The use of remotely piloted or unmanned aerial vehicles, such as Predator, Global Hawk, or tethered aerostats, can be considered as well, since these platforms have the ability to loiter over an area for extended times, enabling them to assist with both damage assessment and rescue operations. Future technologies will allow remotely piloted or unmanned aerial platforms to fill multiple roles, providing imagery and real-time video in support of rescue operations, and at the same time provide an emergency communications relay capability for first responders and other civil communications. The specific technologies available and their capabilities will be explored later in this paper.

From the attacks on 9/11, to Hurricane Katrina and beyond, failures in government response to disasters have been noted, and many lessons learned documented. In the areas of communications and ISR, military assets can be used to assist other government agencies to provide emergency communications, assist in damage assessment, and enhance rescue operations. It is now the responsibility of DHS, DoD, and other government agencies to integrate these lessons into national disaster response planning.

Airborne technologies available now

To build on lessons learned from Hurricane Katrina and enhance the US military's response to future domestic disasters, several technologies can be implemented now. Those technologies include traditional heavier than air RPAs, manned lighter than air (LTA) platforms, tethered aerostats, and free-floating balloons. Each of these technologies will be explored, along with their capabilities that can be used during disaster response operations.

Traditional RPAs

The US military has developed robust RPA programs, ranging from the high-flying, long endurance RQ-4 Global Hawk, all the way down to hand launched, model airplane sized tactical platforms, used by the US Army and Special Forces. Two of these RPAs, the RQ-4 Global Hawk and RQ-1 Predator, are ideally suited for reconnaissance missions in support of military domestic disaster response operations.

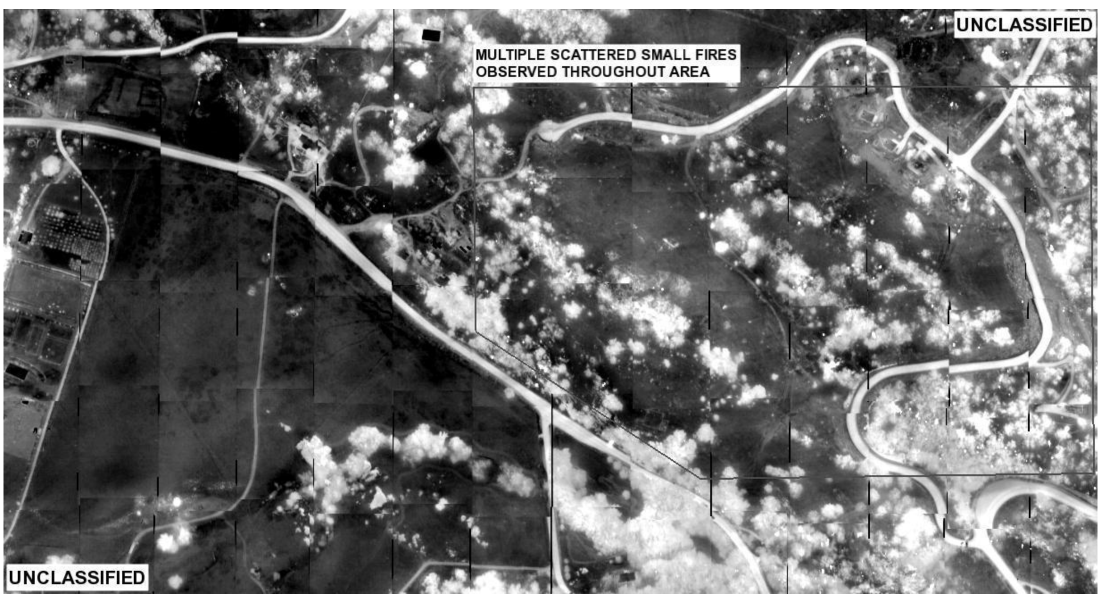

Figure 3: Imagery taken by a Global Hawk of the 2007 California Wildfires[19]

The Global Hawk has been used extensively in domestic and international disaster response operations, in addition to its primary military mission. From its initial domestic use

during the Southern California wildfires in 2007, to support of Operation UNIFIED RESPONSE in Haiti, its detailed imagery capabilities have assisted the US military and civil authorities with situational awareness. During Hurricane Katrina, Global Hawk was prepared to fly in support of the response operation, however civil air traffic controllers did not allow the aircraft to operate in the airspace over New Orleans, due to "air traffic concerns."[20] Pre-coordination with civil aviation authorities and periodic exercises using the Global Hawk over major cities can help alleviate these concerns.

Global Hawk's recent performance in Haiti highlights some the unmanned platform's advantages. First, this RPA provides great flexibility to relief coordinators. On 13 January, 2010, a RQ-4 Global Hawk was enroute to Afghanistan to support Operation ENDURING FREEDOM operations. In response to a USSOUTHCOM request, the aircraft was diverted to fly over Haiti and provide imagery of the earthquake that had just happened a day earlier.[21] The Global Hawk was able to spend 14 hours over Haiti and take hundreds of images, before landing at a base in the US. Lieutenant Colonel Mark Lozier, director of operations for the 12th Reconnaissance Squadron, Beale AFB, CA, said, "One of the ideal aspects of the Global Hawk for this purpose [disaster relief] is it's high-altitude; we can stay airborne 27 to 28 hours. We will be using most of that time to stay on station over in Haiti during most of daylight hours to image most of everything that we can with the highest fidelity."[22] Global Hawk has proven its worth in both combat and disaster relief missions. Use of this platform should be maximized when planning military response to domestic disasters.

Figure 4: An RQ-1 Predator landing in Puerto Rico, following a mission supporting Operations UNIFIED RESPONSE in Haiti[23]

The Global Hawk's, "older brother", the RQ-1 Predator, also offers many benefits for supporting domestic disaster relief operations. The Predator has been used in many roles, ranging from combat operations in the Middle East, to patrolling the US borders. Since 2005, the US Customs and Border Protection Department has been using Predator aircraft to monitor the US-Mexico border for illegal drug trafficking and illegal immigration.[24] These same aircraft, currently operating in a law enforcement capacity, can be re-roled to support humanitarian or disaster relief missions. Predators equipped with synthetic aperture radar (SAR) systems have the ability to capture high-resolution imagery that can be very helpful in finding survivors or locating structural damage after a disaster. Federal response to flooding in North and South Dakota that occurred in early 2009 offered an opportunity for the Predator to showcase its capabilities in a disaster response scenario. According to Mr. John W. Priddy, Deputy Director of Northern Border Patrol, US Customs and Border Protection, the Predator's SAR capability was able to track ice floes in the flooded river. He said, "Using real time data collected over a period of eight hours, we could determine how ice floes are moving and at what rate, and that can help predict if bridges or buildings are in danger."[25]

US Air Force RQ-1s have also shown their usefulness in disaster response operations, most recently in Haiti, as a part of Operation UNIFIED RESPONSE. Predators from Creech AFB, NV, deployed to the devastated island nation to participate in the ongoing disaster response operations. The Predators fly daily sorties over Haiti, providing critical video feeds to military commanders and civilian authorities on the ground. The RQ-1s deployed there are used to assist ground forces and police with urban security operations, pinpointing the locations of fires, and helping to locate survivors.[26]

Both the Global Hawk and Predator have demonstrated their capabilities in disaster response operations, and their use must certainly be continued and expanded in planning for future disaster response operations. Just as with integrating any new capability into an operational plan, exercising and practice are critical. Procedures for deconflicting the use of RPAs in US airspace with civil aviation authorities must be undertaken now, during the planning process, and practiced routinely. The critical capabilities these aircraft provide should not be limited by a lack of coordination between military and civil authorities. Detailed planning and coordination with civil aviation authorities are a key in enhancing domestic disaster response operations with the capabilities of the Global Hawk and Predator RPAs.

Figure 5: Zeppelin NT on an urban surveillance mission[27]

Manned LTA platforms - Airships

Since the 19th century, manned LTA platforms (known as airships) have been used by militaries of the world for functions such as reconnaissance, transport, coastal patrol, and even strategic attack missions. In the 1930s, the US Navy even operated two large rigid-framed airships, the USS Akron and the USS Macon, as flying aircraft carriers.[28] Modern enhancements to this proven technology can provide many benefits that are currently untapped by our nation's military. Current airships, such as American Blimp Corporation's Spector, and the German Zeppelin NT can carry payloads up to 3,000 lbs at altitudes up to 10,000 feet, while being able to stay aloft far longer than traditional aircraft. Endurance is limited, however, by the aircrew and fuel capacity of the particular airframe. Additionally, these airships can carry the latest communications and ISR payloads, which are flexible based on the mission. These types of LTA aircraft are already in use worldwide, performing a variety of missions.

Airships are widely used for commercial applications in the US and Europe. If you are a sports fan, you have probably seen the MetLife or Goodyear blimps flying above a sporting event, providing wide-angle, panoramic video of the arena and surrounding area. The slow speed

and low altitude of these airships, coupled with the ability to capture high-resolution video, make these platforms ideal for supporting military disaster relief operations. Although no airships are currently in active military service, their capabilities as demonstrated in other security operations, make them ideal candidates for military service. Airships have been used for law enforcement purposes worldwide at high profile events. At the 2000 Olympic Games in Atlanta, Georgia, and the 2004 Olympic Games in Athens, Greece, airships were used to monitor key venues and crowds.[29] In 2006, airships equipped with high-resolution video cameras were used by the German government to monitor the World Cup soccer championship taking place there.[30] In New York City, the New York City Police Department used a commercial blimp provided by the Fujifilm Corporation as an intelligence-gathering platform supporting security operations the 2004 Republican National Convention.[31] These manned airships have the capability to provide video surveillance, in addition to carrying communications relay equipment with long loiter times. These platforms can also be used to direct rotary wing aircraft for rescue operations, as observed during Hurricane Katrina operations with the many rooftop rescues that were required. These platforms can provide the military with viable communications and ISR capabilities with technology available right now. These platforms must gain a service advocate, be placed into service, and integrated into domestic disaster response plans.

Figure 6: Lockheed-Martin's PTDS[32]

Aerostats

Aerostats, LTA aircraft tethered to the ground or a ship, have also been used for many years in a variety of applications. During the later days of World War I and throughout World War II, British citizens became familiar with the sight of "barrage balloons" floating around their cities and other industrial sites. Barrage balloons were tethered to the ground with metal cables, and used to defend sites against low-level attack by aircraft by damaging the aircraft on collision with the cables. Some versions carried small explosive charges that go off if impacted by an aircraft.[33] This use of aerostats for air defense was only a glimpse of the missions that these airborne platforms would be accomplishing in the future.

Military operations in Afghanistan and Iraq confronted the US military with some unanticipated challenges. Those challenges include base defense in an urban environment, locating indirect fire positions, and countering the threat of improvised explosive devices (IEDs). The military turned to a proven technology, aerostats, to help meet some of those challenges. One of the aerostat systems currently being used is called the Persistent Threat Detection System (PTDS). The US Army contracted the Lockheed-Martin Corporation to build the system, and the first PTDS system was fielded Iraq in October 2004.[34] The PTDS consists of several elements.

The first, and most observable, element is the aerostat itself. The PTDS aerostat is approximately one-third the size of the Goodyear blimp, weighs about 1000 pounds, and can carry a variety of sensors, including gyro-stabilized day and night vision video cameras, tactical radio relay systems, hypersensitive microphones, and other payloads as required. These airframes can operate at altitudes up to one mile, providing a wide surveillance area. The tether that connects the aerostat to its mooring platform is much more than just a metal cable. The PTDS's "intelligent" tether provides power for the mission payloads, fiber optic cables for transmission of sensor data and control signals, and integrated lightning protection.[35] The video feeds and other data from the PTDS can be integrated into existing communications networks, for distribution to analysts and commanders geographically separated from the platform. The PTDS's mooring platform is mobile, and additional ground shelters house control stations for the system's operators. A crew of only five operators operates the PTDS.[36] US Army Lt Col Terrence Howard, Product Manager, Robotic & Unmanned Sensors, said, "Utilizing multiple sensors, the system delivers images to decision makers in near real-time full motion video allowing for eyes on target."[37] The PTDS was also named one of the US Army's Greatest Inventions of 2005.[38]

The benefits of aerostat systems such as the PTDS are clear. Their wide area surveillance capabilities also make them ideally suited for domestic disaster response. A network of aerostats, equipped with radio relays, broadband Internet access points, and video cameras can have a profound impact on a metropolitan area devastated by a disaster. These systems are combat tested in both Iraq and Afghanistan and are available for immediate purchase and integration into military disaster response operations. Aerostats and their beneficial capabilities must be a part of future disaster response operations.

Figure 7: Launch of a StarFighter communications relay balloon[39]

Free-floating Balloons

Balloons with enhanced with modern communications technology payloads can provide a great capability for disaster response operations, especially in restoring and enhancing radio communications for first responders. Balloons are near-spherical, fully buoyant LTA vehicles that float freely, traveling to very high altitudes. The high altitude reached by these balloons, nearly 80,000 feet, is above commercial air traffic lanes, so the FAA allows them to operate freely. This high altitude also provides a very large communications footprint on the ground. This type of free-floating balloon has already found commercial uses. In Texas, oil companies use balloons to provide communications between remote well heads and company control centers.[40] The use of this technology has allowed communications with these remote sites to remove large microwave communications antennas and satellite dishes, and migrate to small, hand-held devices for voice communications.[41]

The Space Data corporation, a provider of balloons with communications relay payloads, was awarded a $49 million contract with the USAF to provide balloons with military-specification UHF radio repeaters.[42] After award of the contract, a demonstration was conducted with the Air Force Research Laboratory and the Arizona Air National Guard. The test consisted of one of their free-floating balloons, called the StarFighter, carrying a UHF radio repeater at an altitude of 73,000 feet. Two PRC-148 UHF radios at separate locations (70 miles and 320 miles away from the balloon, respectively) were used in the test. The two locations were able to successfully perform voice communications using the StarFighter's repeater, even though the PRC-148s were only using 0.1 watts of power.[43] The Alabama Air National Guard currently operates the StarFighter balloons and associated radio repeaters.

The success of this demonstration proves that these platforms can have a positive effect on both the battlefield, and during disaster response operations. These balloons can be outfitted with repeaters to restore and extend the range of first responder communications during a disaster. Due to their small size and portability, these platforms can be launched in the hours following a disaster to provide immediate communications to first responders and military forces assisting in the response operation. The key to successfully utilizing these platforms is to build plans for exactly which radio frequencies will need to be repeated, so the payloads can be purchased and prepared for deployment far in advance of any disaster. Again, practice and exercises are a key to success here.

Future Technologies

There are many LTA technologies available now that can immediately contribute to domestic disaster response operations, but even more ambitious technologies are on the horizon.

Two of those are the Integrated Sensor is the Structure (ISIS) program, and a hybrid airship called the long endurance multi-intelligence vehicle (LEMV).

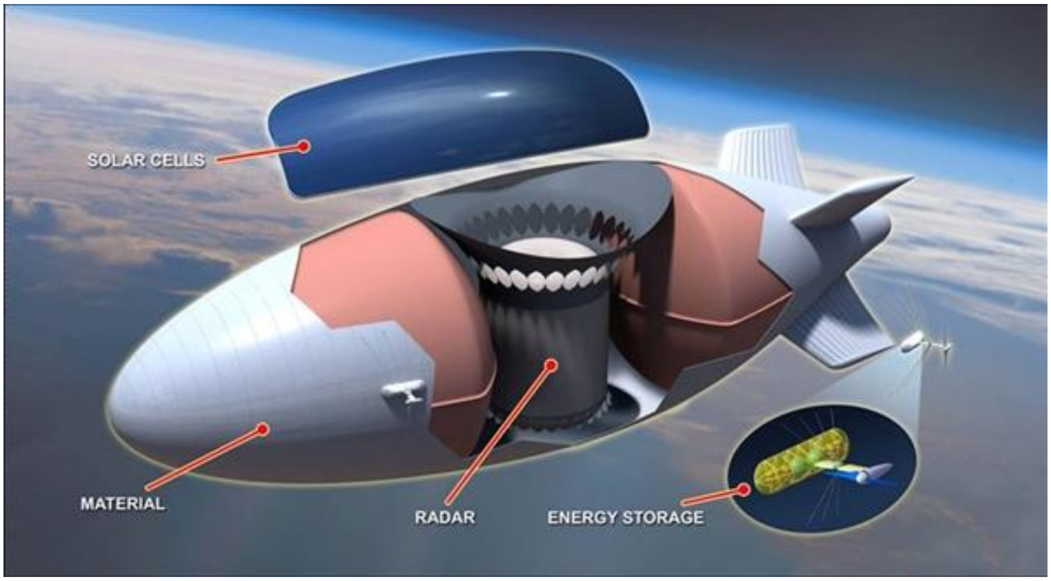

Figure 8: Artist's Conception of DARPA's ISIS high-altitude airship[44]

The Defense Advanced Research Projects Agengy's (DARPA) ISIS aircraft is a high-altitude, unmanned airship, designed to replace the E-3 AWACS and E-8 JSTARS aircraft. The ISIS will be approximately 6,000 square meters across (about the size of a 15-story building), operate at altitudes over 70,000 feet, and it will feature an advanced radar system, twice as powerful as the radars carried by the E-3 and E-8.[45] The airship will also not require ground refueling. It is designed with a regenerative power system, consisting of an array of solar cells and a fuel cell system to power the airship at night. DARPA plans for the ISIS airship to be able to relocate anywhere in the world in about 10 days, and has the ability remain aloft for years, potentially.[46] In April 2009, Lockheed Martin was awarded a contract to build an ISIS demonstrator, which is scheduled for delivery in fiscal year 2013.[47] Just as these capabilities provide a marked advantage to our military forces on the battlefield, this system could be use its advanced sensor capabilities to assist in domestic disaster response operations.

Figure 9: Lockheed-Martin Artist's Conception of hybrid airship[48]

The US Army has taken an interest in advanced LTA aircraft, as well. In January 2010, the service's Space and Missile Defense Command issued a request for proposals for the LEMV contract.[49] The Army requires the LEMV to be optionally manned, fly for up to three weeks, carry multiple intelligence payloads weighing up to 2,500 lbs, provide 16kW power and reach speeds up to 80 knots.[50] The LEMV is a hybrid airship, meaning it combines buoyant, aerodynamic and propulsive lift to enhance performance and make it easier to launch and recover. Once demonstrated and proven, this hybrid airship technology can have applications in domestic disaster response operations.

Operating Costs

As with any system operated by the US military, costs can be a constraint. LTA platforms can cost considerably less to operate than traditional aircraft, while offering some of the same, or better, capabilities. The table below compiles data from the US Navy's Research Advisory Committee, Air Force Global Strike Command, and industry sources, on operating costs of various airborne platforms. The costs provided include manpower, fuel, support, and maintenance.

Airborne Platform	Operating Cost per Hour
RQ-4 Global Hawk	$26,500
RQ-1 Predator	$5,000
UH-1 Huey	$1,485
UH-60 Blackhawk	$2,400
Zeppelin NT	$1,800 (cost based on lease)
Tethered Aerostat (PTDS)	$500

Table 1: Airborne Platform Cost Comparison[51]

As the data indicates, the cost for operating LTA platforms can be lower than some traditional aircraft. Coupled with their greater endurance, LTA platforms are more cost effective to operate for some missions, compared to traditional aircraft.

Figure 10: Zeppelin flying over San Francisco, CA[52]

Future Scenario: The Great Los Angeles Earthquake of 2013

According to a 2008 study sponsored by the US Geological Survey, the probability of a magnitude 6.7 or greater earthquake striking the Los Angeles area within the next 30 years is 67

percent.[53] In 1994, a 6.7 magnitude earthquake, known as the Northridge Earthquake, struck the Los Angeles area, causing massive damage. The earthquake caused 57 deaths, over 9,000 injuries, caused over 20,000 people to be displaced from their homes, and caused an estimated $20 billion in damages.[54] The earthquake only lasted 10-20 seconds, but destroyed thousands of buildings, brought down freeway interchanges, and ruptured gas lines, which caused many fires.[55] Just as in other natural disasters, first responder communications and surveillance and reconnaissance were problems in the most critical, first hours after the earthquake. Given the evidence of these problems from this earthquake and other disasters, it can be assumed that a large earthquake striking the Los Angeles area in 2013 will cause some of the same problems.

In this 2013 scenario, the integration of airborne platforms can help mitigate some of the problems experienced in previous disaster response operations. First, traditional RPAs should be used to provide immediate situational awareness to government officials. The RQ-4 Global Hawk, based at Beale AFB, California, would be able to provide high resolution imagery of the disaster area quickly, because of its close proximity. The imagery provided by the Global Hawk can help direct response efforts to the most heavily damaged areas.

Next, free-floating balloons would be launched over the affected area, to restore first responder radio networks and provide additional radio and data networks for support of response operations. Operating at altitudes over 70,000 feet, these balloons would not interfere with the heightened amount of air traffic over the disaster area. Manned airships would be used to assist in damage assessment, and assist in the search for survivors. Given the large amount of damage that could happen to road surfaces, the low altitudes and extended loiter times of the airships would allow them to move slowly over area for long periods of time, searching for survivors. Controllers aboard these airships would also be able to dispatch rotary wing rescue aircraft as

needed, rather than having them constantly airborne. This solution will be more cost effective than having the rotary wing aircraft orbiting constantly, looking for survivors. At this stage of the operation, Predators could also be operated for persistent ISR over the affected area, if required. Lastly, a network of tethered aerostats would be employed around the disaster area, to continue search and rescue and ISR operations, and also as civil communications relays to provide communications service to citizens who may still be without land-based services.

Conclusion and Recommendations

The US government will certainly have to respond to some type of disaster (whether natural or man-made) in the future. Lessons learned from large-scale domestic disasters such as the September 11th attacks and Hurricane Katrina have highlighted shortfalls is government response operations. Two primary areas are a lack of post-disaster communications, and a need for timely surveillance and reconnaissance of the disaster areas. Airborne platforms, operated and integrated in the proper manner, can help to improve future domestic disaster response operations. There is, however, no single "silver bullet". The various platforms explored in this paper (manned and remotely piloted, LTA and traditional) each have a niche capabilities that will maximize their benefit in a disaster response operation. An ideal disaster response operation will leverage the capabilities of multiple airborne platforms, to improve the overall effort.

Even though the technology exists to integrate many airborne platforms into domestic disaster response operations, a coordinated, multi-agency approach must be undertaken to successfully plan and execute operations using these platforms. The highest area of importance is routine practice and exercise between the federal and local governments. The use of airborne platforms in these scenarios should not come as a surprise to anyone, but as an expected part of the response operation. Their varied uses for ISR and communications restoral will be

invaluable, especially in the first hours following a disaster. The technologies are there, the capabilities are understood, a concerted effort to successfully integrate these airborne platforms into domestic disaster response operations must be undertaken, or we are doomed to repeat the failures of the past.

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